

IN THE SPECIFICATION

Please add the following section headings and title at page 1, before line 1:

TITLE OF THE INVENTION

ROLLER LEVELLER WITH VARIABLE CENTER DISTANCE

BACKGROUND OF THE INVENTION

I. Field of the Invention

Please add the following section heading at page 1, between line 2 and line 3:

II. Description of Related Art

Please amend the paragraphs at page 1, lines 7 to 27, as follows:

However, the rolling operation is insufficient for obtaining a defect-free strip. This is because it exhibits non-developable flatness defects, such as waviness at the edges or the ~~centre~~ center, and/or developable defects such as a curl or a crown, that is to say a curvature either along the length or along the width of the strip, respectively.

These flatness defects can be corrected by levelling the strip in a multi-roll leveller. Such a leveller consists of two superposed cassettes each supporting several motor-driven rolls, of constant diameter, offset with respect to one another and placed alternately above and below the path of the strip. This type of leveller is configured, in terms of the number of rolls, the diameter of the rolls, the ~~centre-to-centre~~ center-to-center spacing and the setting, so as to achieve satisfactory levelling of the strip, the thickness of which lies within a defined range.

In a conventional leveller, the ~~centre-to-centre~~ center-to-center spacings of the rolls are constant and set so that the ratio of the roll diameter to the ~~centre-to-centre~~ center-to-

center spacing is between about 0.90 and about 0.95. However, in this type of leveller, the levelling forces and moments are large. For the purpose of reducing them, manufacturers have developed levellers in which all of the ~~centre-to-centre~~ center-to-center spacings are increased so that the ratio of the diameter to the ~~centre-to-centre~~ center-to-center spacing is around 0.70 to 0.80. However, this no longer allows the non-developable defects to be corrected over the entire range of the leveller in terms of strip thickness, and in particular on a thinner strip.

Please add the following section heading at page 1, between line 31 and line 32:

BRIEF SUMMARY OF THE INVENTION

Please amend the paragraph at page 2, lines 4 to 10, as follows:

For this purpose, the subject of the invention is a tensionless leveller intended for levelling a metal strip, having an entry and an exit, comprising $n+1$ rolls, of the type comprising two superposed cassettes each supporting at least $n/2$ motorized rolls of constant radius R , offset with respect to one another and placed alternately above and below the path of the strip, the axis of each of the rolls of one cassette being separated from the axis of the immediately successive roll of the other cassette by a ~~centre-to-centre~~ center-to-center spacing E_k , in which:

Please amend the paragraphs at page 2, lines 14 to 15, as follows:

for k from 5 to $n-1$, $R/E_n \leq R/E_k \leq R/E_1$, and ~~$R/E_k \leq R/E_{k+1}$~~ $R/E_k \geq R/E_{k+1}$,

said leveller optionally including means for adjusting the ~~centre-to-centre~~ center-to-center spacings E_k .

Please amend the paragraph at page 2, lines 25 to 26, as follows:

- for k from 1 to x, $0.90 \leq R/E_k \leq 0.95$, one of the ~~centre-to-centre~~ center-to-center spacings E_x , where $5 \leq x \leq n-4$, being such that:

Please amend the paragraph at page 2, lines 28 to 29, as follows:

- for k from 1 to x, $0.90 \leq R/E_k \leq 0.95$, one of the ~~centre-to-centre~~ center-to-center spacings E_x , where $5 \leq x \leq n-4$, being such that:

Please amend the paragraph at page 3, lines 4 to 10, as follows:

As will have been understood, the invention consists in proposing a leveller in which at least the first five rolls starting from the entry of the leveller have a ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio identical to that of conventional levellers, in which at least the last five rolls from the entry of the leveller have a ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio close to that of a decurler, and in which the ~~centre-to-centre~~ center-to-center spacing between the intermediate rolls of the leveller is advantageously increased.

Please add the following section heading at page 3, between line 10 and line 11:

BRIEF DESCRIPTION OF THE DRAWINGS

Please add the following section heading at page 3, between line 21 and line 22:

DETAILED DESCRIPTION OF THE INVENTION

Please amend the paragraphs at page 3, line 22 to page 4, line 27, as follows:

Figure 1 shows schematically a leveller 1 comprising a lower cassette 2 and an upper cassette 3 being two superposed cassettes 2, 3, each supporting motorized rolls 4, 4' of constant radius R. To level a metal strip 5, this strip 5 is made to run between the rolls 4, 4' and a leveller entry, corresponding to the entry of the strip 5 into the leveller 1, and a leveller exit, corresponding to the exit of the strip 5 from the leveller 1, are thus defined. The rolls 4, 4' are positioned so as to be offset one with respect to another and placed alternately above and below the path of the metal strip 5. To obtain correct levelling of the strip 5, each cassette 2, 3 must support at least $n/2$ rolls 4, 4' and, more precisely, for a leveller 1 comprising $n+1$ rolls 4, 4', the lower cassette 2 comprises $(n/2)+1$ rolls 4 and the upper cassette 3 comprises $n/2$ rolls 4'. The axis of each of the rolls 4, 4' of a given cassette 2, 3 is separated from the axis of the immediately successive roll 4, 4' of the other cassette by a ~~centre-to-centre~~ center-to-center spacing E_k , which can be varied.

To obtain a levelled strip 5 with a zero curl, it is necessary to set the gap between the rolls 4 of the lower cassette 2 and the rolls 4' of the upper cassette 3 located on the exit side of the leveller 1, that is to say to set the entry clamping and exit clamping of the leveller 1. To adapt the setting according to the type of strip 5 to be levelled, the ~~centre-to-centre~~ center-to-center spacing E_k may be varied using adjustment means (not shown).

The inventors have demonstrated by reducing the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio of the rolls down to a value of around 0.8, starting from the fifth roll from the entry of the leveller, in a leveller whose ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio between at least the first five rolls from the entry of the leveller corresponds to the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio of a conventional leveller, the levelling forces and moments can be reduced by 5 to 25% depending on the type of adjustment made.

Thus, for the first five rolls from the entry of the leveller, that is to say when k varies from 2 to 4, the R/E_k ratio is equal to the ratio R/E_1 , in which E_1 corresponds to the ~~centre-to-centre~~ center-to-center spacing between the first roll from the entry of the leveller and the second roll from the entry of the leveller, R/E_1 being between 0.90 and 0.95, limits inclusive, which values correspond to the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio of a conventional leveller.

For the last five rolls from the entry of the leveller, that is to say when k varies from n-3 to n, the R/E_k ratio is equal to the ratio R/E_n , in which E_n corresponds to the ~~centre-to-centre~~ center-to-center spacing between the last roll from the entry of the leveller and the penultimate roll from the entry of the leveller, R/E_n being between 0.70 and 0.80, limits inclusive, which values correspond to the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio of a conventional decurler.

Please amend the paragraph at page 4, line 33, as follows:

$$R/E_n \leq R/E_k \leq R/E_1, \text{ and } \cancel{R/E_k \leq R/E_{k+1}} \quad \underline{R/E_k \geq R/E_{k+1}},$$

Please amend the paragraph at page 5, lines 14 to 17, as follows:

In order for the non-developable flatness defects of the strip to be properly corrected, it is essential for the R/E_k ratio to be equal to the R/E_1 ratio, to within the accuracy of setting the ~~centre-to-centre~~ center-to-center spacing between the rolls, for at least the first five rolls from the entry of the leveller.

Please amend the paragraphs at page 5, line 31 to page 7, line 4, as follows:

According to a first embodiment of the invention, the leveller is divided into two zones. A first zone is thus between the first roll from the entry of the leveller and the (x+1)th

roll from the entry of the leveller, that is to say when k varies from 1 to x , and extends at least as far as the fifth roll from the entry of the leveller. In this first zone, the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is constant and between 0.90 and 0.95 (limits inclusive). The second zone lies between the $(x+1)$ th roll from the entry of the leveller and the last roll from the entry of the leveller, which is the $(n+1)$ th roll, that is to say when k varies from $x+1$ to n , and starts at least from the $(n-3)$ th roll from the entry of the leveller. In this zone, the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is constant and between 0.70 and 0.80 (limits inclusive).

According to a second embodiment of the invention, the leveller is divided into three zones. A first zone lies, as in the first embodiment, between the first roll from the entry of the leveller and the $(x+1)$ th roll from the entry of the leveller, that is to say when k varies from 1 to x , and extends at least as far as the fifth roll from the entry of the leveller. In this zone, the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is constant and between 0.90 and 0.95 (limits inclusive). Next, a second zone in which one of the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratios, which will be called R/E_x , is between 0.80 and 0.90 (limits inclusive). This second zone lies between the fifth roll from the entry of the leveller and the $(n-4)$ th roll from the entry of the leveller, that is to say when x varies from 5 to $n-4$. Finally, a third zone lies between the $(x+1)$ th roll from the entry and the last roll of the leveller (the $(n+1)$ th roll), that is to say when k varies from $x+1$ to n . In this third zone, the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is constant and between 0.70 and 0.80 (limits inclusive).

In a third embodiment of the invention, the leveller is again divided into three zones. A first zone lies, as in the previous embodiments, between the first roll from the entry of the leveller and the $(x+1)$ th roll from the entry of the leveller, that is to say when k varies from 1 to x , and extends at least as far as the fifth roll from the entry of the leveller. In this zone, the

~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is between 0.90 and 0.95 (limits inclusive). Next, a second zone in which one of the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratios, which will be called R/E_x is between 0.80 and 0.90 (limits inclusive) and the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_{x+1} is between 0.75 and 0.85 (limits inclusive). This second zone lies between the fifth roll from the entry of the leveller and the $(n-4)$ th roll from the entry of the leveller, that is to say when x varies from 5 to $n-4$. Finally, a third zone lies between the $(x+2)$ th roll from the entry of the leveller and the last roll of the leveller (the $(n+1)$ th roll), that is to say when k varies from $x+2$ to n . In this third zone, the ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k is constant and between 0.70 and 0.80 (limits inclusive).

Please amend the paragraph at page 5, lines 19 to 23, as follows:

A conventional leveller, denoted by leveller X, comprising $(k+1)$ rolls with k equal to 16, i.e. seventeen rolls, with a diameter of 57 mm and a constant ~~centre-to-centre~~ center-to-center spacing E_k of 30 mm (a leveller of the BRONX type), therefore having a constant ~~radius/centre-to-centre~~ radius/center-to-center spacing ratio R/E_k of 0.95, was modified in order to obtain various levellers according to the invention, namely:

Please delete the current Abstract at page 12, lines 1 to 12, and add in its place the new Abstract on the following page: